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(71) Applicant: FED CORPORATION [US/US]; Hudson Valley Research Park, 1580 Route 52, Hopewell Junction, NY 12533 (US).

(72) Inventors: SOKOLIK, Igor; RR2, Box 3, Route 82, Verbank, NY 12585 (US). GHOSH, Amalkumar, P.; 22 Colette Drive, Poughkeepsie, NY 12601 (US).

(74) Agents: COYNE, Patrick, J. et al.; Collier, Shannon, Rill & Scott, PLLC, Suite 400, 3050 K Street, N.W., Washington, DC 20007 (US).

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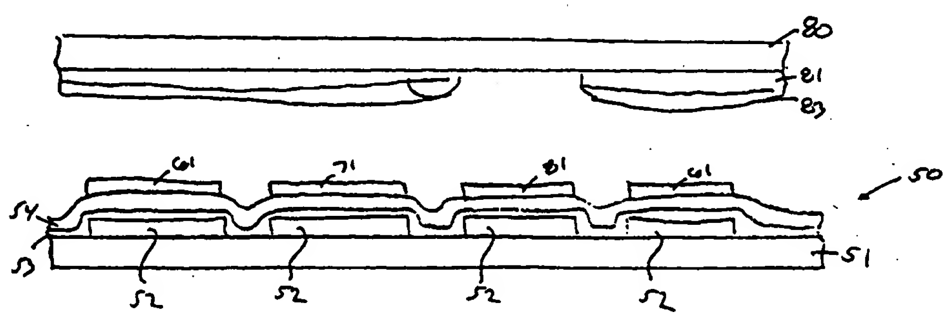

(57) Abstract

The present invention is directed to a method of fabricating a full color organic light emitting diode display (50). The method includes the step of providing a wafer including at least one of prefabricated circuitry, a bottom electrode and at least one organic layer (52). The method further includes the step of providing a first substrate having a first color specific organic light emitting layer (61) formed thereon. The method also includes the step of selectively applying electromagnetic radiation to the first substrate to transfer portions of the color specific light emitting layer onto to the wafer to form at least one first color specific subpixel.

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FABRICATION METHOD FOR HIGH RESOLUTION FULL COLOR ORGANIC LED DISPLAYS

Cross Reference To Related Patent Application

This application relates to and claims priority on provisional application serial number 60/099,294, filed September 4, 1998.

Field of the Invention

The present invention relates to a fabrication method for high resolution full color organic light emitting diode ("OLED") displays. In particular, the present invention relates to a method of selectively depositing emitting elements or portions thereof on the subpixels of desired color on the OLED display.

Background of the Invention

There are several approaches to producing color OLED displays, among them: subpixels emitting white light with color filters on top of the subpixels; subpixels emitting blue light with fluorescing color changing media (CCM) on top of subpixels; and self-emissive pixelated display with red, green and blue subpixels placed next to each other. Two former approaches are technologically feasible because all subpixels emit the same color and filter media can be patterned independently and then aligned on top of OLED subpixels. The latter approach, in principle, allows best possible performance because no light is lost for filter absorption or color conversion. It, however, requires precise shadow mask fabrication and alignment in the process of vacuum deposition for displays using low-molecular-weight materials. It is also very difficult, if not technologically impossible, to fabricate shadow masks for miniature high-resolution displays with a subpixel size of few microns. Alternatively, photolithographic patterning that includes wet processing may be used. This introduces potential hydrolysis and oxidation of organic OLED materials.

For color OLED displays, the two former approaches are technologically more feasible because all pixels emit the same color, and CCM and/or color filters can be patterned independently and then aligned on top of OLED pixels. The display design that uses blue color monochrome pixelated display with CCM (and, possibly, some color filters for spectral

correction) is preferable for the following reasons: a) it uses blue monochrome display thus eliminating problem of differential aging of phosphor components; b) blue light absorbed by the CCM media and re-emitted with high quantum efficiency of luminescence can provide higher display brightness than white display with color filters; (c) thin films of highly absorbing CCM can be evaporated directly on top of the transparent display encapsulation layer thus maximizing light collection and eliminating cross-talk between neighboring pixels. The idea of using this type of color displays is known from the prior art (Kodak and Idemitsu patents). Usually, CCM layer(s) is patterned using lithography, which is a multi-step process and often requires wet processing. This increases product cost and introduces potential damage to the OLED display.

Objects of the Invention

It is an object of the present invention to provide a method of forming side by side subpixels for producing miniature full color OLED displays.

It is another object of the present invention to provide a method of fabricating a full color OLED display having reduced manufacturing steps.

It is another object of the present invention to provide a method of patterning an emitter layer of an OLED display having reduced manufacturing steps.

It is another object of the present invention to provide a method of patterning an emitter layer of an OLED display at lower fabricating costs.

It is another object of the present invention to provide an improved method of patterning an emitter layer of an OLED display having reduced manufacturing time.

It is another object of the present invention to provide a method of fabricating a full color OLED display with reduced contamination.

It is another object of the present invention to provide a method of patterning an emitter layer with reduced contamination.

It is another object of the present invention to provide a method of patterning an emitter layer without solvents.

It is another object of the present invention to provide a full color OLED display without filters or color changing media.

It is another object of the present invention to provide a full color OLED display that operates at a lower power and voltage.

It is another object of the present invention to provide a full color OLED display that operates with increased power efficiency and display lifetime.

It is an object of the present invention to provide an OLED display having reduced subpixel size, wherein subpixel size is limited by the diffraction of light only.

Summary of the Invention

The present innovation is directed to a new effective method for fabrication of high-resolution full color passive or active matrix self-emitting OLED displays with independently driven red, green and blue emitting elements (subpixels) placed next to each other. This fabrication method can be applied for OLEDs with layers made of organic materials including low-molecular weight materials, oligomers and polymers, or combination of those prepared by vacuum deposition, spin-coating, self-assembly, Langmuir-Blodgett or any other technique or combination of those. This fabrication method can also be applied for OLEDs with layers made of organic and inorganic materials. The main idea of the suggested method is to selectively transfer certain areas of prefabricated organic layer for OLED, or of combination of those layers, or of whole OLED structure including one or both electrodes, or of whole OLED structure including one or both electrodes and passivation layer, from the source substrate to the receiving wafer or substrate with prefabricated electronic circuitry, active- or passive matrix structure, and, possible, bottom electrode and one or few organic layers in such a way that subpixels corresponding to one color only are covered at a time. Transfer of named layer(s) should occur due to laser ablation from the source substrate or by instant heating of the latter in vacuum.

The present invention is directed to a method of fabricating a full color organic light emitting diode display. The method includes the step of providing a wafer including at least one of prefabricated circuitry, a bottom electrode and at least one organic layer. The method further includes the step of providing a first substrate having a first color specific organic light emitting layer formed thereon. The method also includes the step of selectively

applying electromagnetic radiation to the first substrate to transfer portions of the color specific light emitting layer onto to the wafer to form at least one first color specific subpixel.

In accordance with the present invention, the first substrate includes a release layer located between the substrate and the first color specific light emitting layer. The source of electromagnetic radiation may be a UV light source.

In accordance with the present invention, the method may further include the step of removing the substrate having a first color specific organic light emitting layer formed thereon, after formation of the at least one first color specific subpixel. The method may further include the steps of providing a substrate having a second color specific organic light emitting layer formed thereon, and selectively applying the electromagnetic radiation to the second substrate to transfer portions of the second color specific light emitting layer onto to the wafer to form at least one second color specific subpixel.

In accordance with the present invention, the second substrate may further include a release layer located between the second substrate and the second color specific light emitting layer. The release layer is designed to protect the at least one organic layer damage by the UV light used for ablation. Additionally, the first color specific light emitting layer may be different from the second light emitting layer.

The method may further include the steps of removing the second substrate after formation of the at least one second color specific subpixel, providing a third substrate having a third color specific organic light emitting layer formed thereon, and selectively applying the electromagnetic radiation to the third substrate to transfer portions of the third color specific light emitting layer onto to the wafer to form at least one third color specific subpixel.

In accordance with the present invention, the third substrate may further include a release layer located between the third substrate and the third color specific light emitting layer. Additionally, the first color specific light emitting layer and the second light emitting layer may be different from the third light emitting layer.

The present invention is also directed to a new effective method for fabrication of high-resolution full color passive- or active matrix self-emitting OLED displays with

independently driven red, green and blue emitting elements (subpixels) placed next to each other. This fabrication method may be applied for blue color OLEDs with layers made of organic materials including low-molecular weight materials, oligomers and polymers, or combination of those prepared by vacuum deposition, spin-coating, self-assembly, Langmuir-Blodgett or any other technique or combination of those. This fabrication method can also be applied for blue OLEDs with layers made of organic and inorganic materials. This fabrication method can also be applied for any type of blue light emitting displays using CCM to produce full color. The main idea of the suggested method is to selectively transfer certain areas of pre-fabricated CCM layer, or of a color filter, or combination of CCM layer and color filter, from the source substrate to the receiving wafer with pre-fabricated electronic circuitry and active- or passive OLED monochrome display in such a way that pixels corresponding to one color only are covered at a time. Transfer of the named layer(s) may occur due to laser ablation from the source substrate or by instant heating of the latter in vacuum. Source substrate is made of thin material non-transparent to UV and visible light (i.e., metal, ceramics) and instead of ablation the proper area(s) of this substrate is (are) instantly heated by pulsed focused source of electromagnetic radiation such as IR light or electron or ion beam. Low substrate thickness prevents spreading of heat across the substrate and allows selective heating of organic areas on this substrate. This technique is applicable to vacuum deposition of CCM layer only and requires vacuum between source substrate and wafer. All of the above is for up-emitting active matrix display. All of the above is for down-emitting passive and active matrix displays when CCM and/or color filters and monochrome pixelated displayed are placed on the opposite sides of the transparent support.

The above-described method eliminates the air gap between display and CCM/color filters because they can be placed directly on top of the display. That improves color quality because cross-talk between pixels of color bleeding decreases dramatically. That also improves display brightness and power efficiency because all light emitted from the top electrode is now collected by the CCM/color filter. The present invention also makes the process of CCM and/or color filter deposition much easier and cheaper because only optical alignment of display wafer and source substrate with CCM/filter layer is needed, and ablation

is a single step process. The present invention also eliminates using a shadow mask and multi-step lithography, both processes not practical for miniature OLED displays with pixel size of few microns. Elimination of wet and/or oxygen plasma processing used for lithography decreases contamination and improves display lifetime significantly. The selective deposition of CCM and elements or part of them on the pixels of proper color. Minimum size of pixel is limited by the diffraction of light only. For visible and near UV laser sources the diffraction limit is less or about 0.3-0.5 μm.

The present invention is also directed to a method of fabricating a full color organic light emitting diode display. The method may include the steps of providing a wafer having at least one organic light emitting diode formed thereon, providing a first source substrate having at least a first color changing layer formed thereon, and positioning said first source substrate adjacent said wafer, and selectively transferring a portion of said at least a first color changing layer from said first source substrate to said at least one organic light emitting diode.

In accordance with the present invention, the step of selectively transferring the at least a first color changing layer includes the step of ablating the first source substrate to selectively transfer a portion of the at least a first color changing layer to the at least one organic light emitting diode.

The method may further include the steps of removing the first source substrate after transferring the at least a first color changing layer from the first source substrate to the at least one organic light emitting diode, providing a second source substrate having at least a second color changing layer formed thereon, positioning the second source substrate adjacent the wafer, and selectively transferring a portion of the at least a second color changing layer from the second source substrate to the at least one organic light emitting diode.

In accordance with the present invention, the step of selectively transferring the at least a second color changing layer includes the step of ablating the second source substrate to selectively transfer a portion of the at least a second color changing layer to the at least one organic light emitting diode.

The method may further include the steps of removing the second source substrate after transferring the at least a second color changing layer from the second source substrate to the at least one organic light emitting diode, providing a third source substrate having at least a third color changing layer formed thereon, positioning the third source substrate adjacent the wafer, and selectively transferring a portion of the at least a third color changing layer from the third source substrate to the at least one organic light emitting diode.

In accordance with the present invention, the step of selectively transferring the at least a third color changing layer includes the step of ablating the third source substrate to selectively transfer a portion of the at least a third color changing layer to the at least one organic light emitting diode.

Brief Description of the Drawings

The invention will now be described in conjunction with the following drawings in which like reference numerals designate like elements and wherein:

Fig. 1 illustrates the alignment of the wafer or substrate and the source substrate prior to the ablation process as part of formation of the high resolution full color OLED display according to a first embodiment of the present invention;

Fig. 2 illustrates the ablation process according to the fabrication method of the first embodiment of the present invention;

Fig. 3 illustrates the transfer of at least the organic layer according to the fabrication method of the first embodiment of the present invention;

Fig. 4 illustrates the alignment of the wafer or substrate and the source substrate in accordance with the ablation of a first color filter or CCM layer according to a second embodiment of the present invention;

Fig. 5 illustrates the transfer of the first color filter or CCM layer according to the fabrication method according to the second embodiment of the present invention;

Fig. 6 illustrates the alignment of the wafer or substrate and the source substrate in accordance with the ablation of a second color filter or CCM layer according to a second embodiment of the present invention;

Fig. 7 illustrates the transfer of the second color filter or CCM layer according to the fabrication method according to the second embodiment of the present invention;

Fig. 8 illustrates the alignment of the wafer or substrate and the source substrate in accordance with the ablation of a third color filter or CCM layer according to a second embodiment of the present invention; and

Fig. 9 illustrates the transfer of the third color filter or CCM layer according to the fabrication method according to the second embodiment of the present invention.

Detailed Description of Preferred Embodiments

A method of fabricating a full color OLED display having high resolution will now be described in connection with Figs. 1-3. The individual subpixels of the OLED display have the same layer composition and structure. The blue, green and red OLED subpixels differ only by the chemical composition of the emitting layer.

In accordance with the present fabrication technique, a bottom or first electrode, at least one organic layer and transport layer are deposited on a wafer or substrate **10**. The first electrode, at least one organic layer and transport layer are collectively referenced as reference numeral **11** in Figs. 1-3. The formation of a blue subpixel, for example, will now be described.

A source substrate **20** is predeposited with a doped emitter layer **22**. A release layer **21** is also predeposited between the source **20** and doped emitter layer **22**. The doped emitter layer **22** has a sufficient thickness of several hundred Angstrom.

The source substrate **20** and the wafer or substrate **10** are separated by spacers **30**. The source substrate **20** and the wafer or substrate **10** are separated by a distance of less than 1 μm. The substrate **20** and wafer or substrate **10** are located in inert gas atmosphere.

Laser light **40** is used for the ablation of the doped emitter layer **22** to transfer the layer **22** to the subpixel **1** as shown in Fig. 2. The laser light **40** is aligned on the substrate **20** such that only areas facing the blue subpixels **1** will be exposed to the laser light **40**, as shown in Fig. 1.

The release layer **21** facilitates the ablation process. The release layer **21** is preferably formed from a thin layer of an appropriate material which is highly absorbing of the

wavelength of light used during the ablation. For example, the release layer **21** may be formed from a polyimide that is capable of absorbing UV light. The present invention, however, is not limited to the use of polyimide; rather other materials with suitable wavelength absorbing properties are considered to be within the scope of the present invention. The release layer also protects organic OLED's layers from photo decomposition.

When the laser light **40** is applied to the source substrate **20**, as shown in Fig. 1, the release layer **21** strongly absorbs the UV light and ablates. It is preferred that the source substrate **20** be exposed to a pulsed laser light. This permits the transfer of doped emitter layer **22**, as shown in Fig. 2, while preventing disintegration of the emitter layer **22**.

When the layer **22** has been transferred to the blue subpixel **1**, as shown in Fig. 3, the substrate **20** is removed and replaced with a new source substrate having an emitter layer for formation of green subpixels. The laser light **40** is realigned such that areas of the substrate facing the green subpixels will be exposed. The ablation process is then repeated. The same procedure is repeated for the formation of red subpixels. Once the formation of the blue, green and red subpixels is complete, the remaining organic layer or layers and the top or second electrode are deposited on the subpixel. This is performed in a separate chamber.

While this invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, the preferred embodiments of the invention as set forth herein are intended to be illustrative, not limiting.

For example, it is contemplated by the inventors of the present invention that more than one organic layer of the OLED may be transferred during the ablation process. The whole stack of OLED's organic layers may be transferred by the ablation process. Furthermore, it is contemplated that the whole stack of organic layers and the second electrode may be transferred by the ablation process, whereby only the bottom or first electrode is pre-deposited on the wafer or substrate. Finally, the transferring of the entire OLED including electrodes by the ablation process is contemplated by the present inventors and considered to be within the scope of the present invention.

It is contemplated by the inventors of the present invention that an antireflection layer may be pre-deposited on the source substrate between the second electrode and the release layer and between the release layer and the OLED. The antireflection layer may be transferred by the ablation process.

It is contemplated that an encapsulating material, including for example a getter material, may be pre-deposited on the source substrate between the second electrode and the release layer and the OLED, wherein the encapsulating material is transferred during the ablation process to encapsulate the display.

It is further contemplated that the encapsulating material may be used in conjunction with the antireflection layer, described above. Furthermore, it is contemplated that the material used to form the release layer may be used to encapsulate the OLED device.

It is also contemplated by the inventors of the present invention to pattern the second electrode on the source substrate such that only areas of the organic layer to be transferred to the wafer or substrate are open to the ablating light. This produces better edge definition of the transferred pattern. This may be used for each of the layers of the OLED display to be transferred during the ablation process.

It is also contemplated by the inventors of the present invention to pattern the release layer on the source substrate such that only OLED areas having the release layer will be transferred to the wafer or substrate.

It is also contemplated by the present invention that the layers may be transferred by instantly heating through a pulsed focused source of electromagnetic radiation. The source of electromagnetic radiation may be IR light, an electron beam or an ion beam. With this process, the source substrate should be formed from a thin material that is non-transparent to UV and visible light. The substrate may be formed from a metal or a ceramic. The thin substrate material prevents the spreading of heat across the source substrate, which allows for the selective heating of organic areas on the substrate. It is preferred that this process be used in connection with the vacuum deposition of the emitter layer only. This requires the use of a vacuum between the source substrate and the wafer or substrate.

Another method of fabricating a full color OLED display having high resolution will now be described in connection with Figs. 4-9. In accordance with this embodiment, a full color OLED display **50** using color changing media (CCM) is produced using laser ablation. The present method will be described, by way of example, in connection with the fabrication of a passive matrix monochrome display **50**. The display **50** has independently addressable blue OLED pixels. The present invention, however, is not limited to the fabrication of a display **50** consisting of upwardly emitting independently addressable blue pixels; rather, both upwardly and downwardly emitting OLED devices are considered to be well within the scope of the present invention. Furthermore, other blue OLED displays (including, but not limited to polymers.), organic/inorganic blue LED display, inorganic blue LED displays are considered to be well within the scope of the present invention. Additionally, full color up-emitting active matrix display and both downwardly emitting passive and active matrix displays are considered to be well within the scope of the present invention.

In accordance with the present invention, a pixelated upwardly emitting active matrix display **50** is independently formed. A single display or a number of displays may be pre-fabricated on a wafer or substrate **51**. The display **50** is preferably formed on silicon substrate or wafer. It, however, is contemplated that other suitable substrate materials are considered to be well within the scope of the present invention. The substrate **51** preferably incorporates driving electronics and a buffer electrode. At least one organic stack **52** is formed on the substrate for each pixel.

The top layer **53** of the display **50** includes a transparent or semi-transparent top electrode. The top electrode **53** is preferably formed from a thin metal including but not limited to Mg:Ag, indium tin oxide (ITO), Mg:Ag with ITO on top of it, IZO, and Ca with ZnSe on top of it. The top electrode **53**, however, is not limited to these materials; rather, it is contemplated that other suitable materials for forming the top electrode are considered to be well within the scope of the present invention. A semi-transparent encapsulation layer **54** may be provided on top of the top electrode **53**.

The wafer or substrate **51** includes optical alignment marks, not shown. The optical alignment marks are placed outside the display area. The marks are provided for alignment with a semi-transparent substrate **60, 70** or **80,** discussed below.

A source substrate **60** is used in connection with the fabrication of the full color OLED display **50**. The source substrate **60** is preferably formed from a semi-transparent material (e.g., glass). In the case of blue OLED, a blue filter layer **61** (for correction of spectral coordinates for blue color emitted by the OLED display) with thickness of less than a pixel size (2-3 microns) is pre-deposited on the source substrate **60**. The source substrate **60** includes alignment marks, not shown. The source substrate **60** and the wafer **51**, which are separated by a spacer of less than 1 μm, are placed in an inert atmosphere. The alignment marks on the source substrate **60** and the wafer **51** are aligned. Laser light used for ablation of organic layers is aligned in such a way that only areas facing designated blue display pixels or rows/columns of designated blue display pixels will be exposed.

To facilitate the ablation process, a thin release layer **62** of an appropriate material (such as polyimide), which is highly absorbing in the wavelength of interest (UV) is deposited on the source substrate **60** prior to deposition of the filter layer **61**. This release layer **62** will strongly absorb the UV light and ablate, thereby releasing the ablated area including the blue filter layer **61** from the source substrate **60**. An adhesive layer **64** may be provided on the filter layer **61** prior to the ablation process to enhance adhesion of the filter layer **61** to the top electrode **53**. During fabrication, a laser pulse hits the source substrate **60**, which transfers the color filter **61** or CCM and adhesive layers **63** to the display **50**. These layers are placed on top of the corresponding display subpixels, as shown in Figs, 4-9. This can be accomplished on a pixel-by-pixel, row-by-row basis or a whole display per laser shot. The color filter layer **61**, CCM layers **71** and **81** and adhesive layer leave the source substrate **60, 70,** and **80** only the areas that have a release layer if the pulse energy of the laser is chosen correctly, as shown in Figs. 5, 7 and 9. In connection with the blue filter layer **61**, the blue filter layer **61** is transferred and secured to the top electrode/encapsulation layer. The release layer **62** prevents the disintegration of the organic color filter layer.

In accordance with the present invention, the release layer **61**, **71** and **81** is pre-patterned such that the it corresponds to the display pattern. The blue color filter layer **61** and the CCM layers **71** and **81**, described below, are not patterned; rather, these layers deposited by either vacuum deposition, or spin-coating or spray coating, or any other technique allowing deposition of uniform layer having a thickness of less than a few microns.

When the transfer of blue filter layer **61** is completed, as shown in Fig. 5, the source substrate **60** is replaced with the new source substrate **70** having a blue-to-red CCM layer **71**. The new source substrate **70** also includes a release layer **72** and an adhesive layer **73**, as described above. Laser light used for ablation of organic layers is realigned in such a way that only areas facing designated red pixels or rows/columns of designated red pixels will be exposed and the ablation process described above is repeated.

When the transfer of blue-to-red CCM layer **71** is completed, as shown in Fig.7, the source substrate **70** is replaced with the new source substrate **80** having a blue-to-green CCM layer **81**. The new source substrate **80** also includes a release layer **82** and an adhesive layer **83**, as described above. Laser light used for ablation of organic layers is realigned in such a way that only areas facing designated green pixels or rows/columns of designated green pixels will be exposed and the ablation process, described above, is repeated to transfer the layer **81**, as shown in Fig. 9. The blue-to-green and blue-to-red source substrates **70** and **80** differ only by CCM and possibly by color filters. Both source substrates **70** and **80** include alignment marks.

Upon completion of the transfer of the filter layers **61** and the CCM layers **71** and **81**, at least one encapsulation layer(s) is deposited the assembly in a separate chamber to seal the display.

While this invention has been described in conjunction with a specific embodiment, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. For example, an anti-reflection layer may be pre-deposited on the source substrate between CCM layer and/or color filter layer and release layer. The anti-reflection layer may also include a getter material. Furthermore, an encapsulating material, preferably containing a getter material, may be pre-deposited on the source substrate between CCM and

the release layer for the final source substrate to encapsulate the display. Alternatively, the material forming the release layer may also for an encapsulating layer on the display **50**.

Additionally, the source substrate may be made of thin material (i.e., metal , ceramics) that is non-transparent to UV and visible light. Instead of above described ablation process, the proper area(s) of the source substrate are instantly heated by a pulsed focused source of electromagnetic radiation(e.g., IR light, electron beam or ion beam). A low substrate thickness prevents spreading of heat across the substrate and allows selective heating of organic areas on this substrate. This technique is applicable to vacuum deposition of CCM layer and only requires vacuum between source substrate and wafer.

In the case of the downwardly emitting display, the CCM and/or color filters and monochrome pixelated display are placed on the opposite side of the transparent substrate.

While this invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, the preferred embodiments of the invention as set forth herein are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A method of fabricating a full color organic light emitting diode display, said method comprising the steps of :

providing a wafer including at least one of prefabricated circuitry, a bottom electrode and at least one organic layer;

providing a first substrate having a first color specific organic light emitting layer formed thereon; and

selectively applying electromagnetic radiation to the first substrate to transfer portions of the color specific light emitting layer onto to the wafer to form at least one first color specific subpixel.

2. The method according to Claim 1, wherein the first substrate includes a release layer located between the substrate and the first color specific light emitting layer.

3. The method according to Claim 1, wherein the source of electromagnetic radiation is a UV light source.

4. The method according to Claim 1, further comprising the steps of:

removing the substrate having a first color specific organic light emitting layer formed thereon, after formation of the at least one first color specific subpixel;

providing a substrate having a second color specific organic light emitting layer formed thereon; and

selectively applying the electromagnetic radiation to the second substrate to transfer portions of the second color specific light emitting layer onto to the wafer to form at least one second color specific subpixel.

5. The method according to Claim 3, wherein the second substrate includes a release layer located between the second substrate and the second color specific light emitting layer.

6. The method according to Claim 3, wherein the first color specific light emitting layer is different from the second light emitting layer.

7. The method according to Claim 3, further comprising the steps of:

removing the second substrate after formation of the at least one second color specific subpixel;

providing a third substrate having a third color specific organic light emitting layer formed thereon; and

selectively applying the electromagnetic radiation to the third substrate to transfer portions of the third color specific light emitting layer onto to the wafer to form at least one third color specific subpixel.

8. The method according to Claim 6, wherein the third substrate includes a release layer located between the third substrate and the third color specific light emitting layer.

9. The method according to Claim 6, wherein the first color specific light emitting layer and the second light emitting layer are different from the third light emitting layer.

10. The method according to Claim 2, wherein a release layer is designed to protect said at least one organic layer damage by the UV light used for ablation.

11. A method of fabricating a full color organic light emitting diode display, said method comprising the steps of:

providing a wafer having at least one organic light emitting diode formed thereon;

providing a first source substrate having at least a first color changing layer formed thereon;

positioning said first source substrate adjacent said wafer; and

selectively transferring a portion of said at least a first color changing layer from said first source substrate to said at least one organic light emitting diode.

12. The method according to Claim 11, wherein said step of selectively transferring said at least a first color changing layer includes the step of ablating said first source substrate to selectively transfer a portion of said at least a first color changing layer to said at least one organic light emitting diode.

13. The method according to Claim 11, wherein said first source substrate includes a release layer selectively positioned between said first source substrate and said at least a first color changing layer.

14. The method according to Claim 11, further comprising the steps of:

removing said first source substrate after transferring said at least a first color changing layer from said first source substrate to said at least one organic light emitting diode;

providing a second source substrate having at least a second color changing layer formed thereon;

positioning said second source substrate adjacent said wafer; and

selectively transferring a portion of said at least a second color changing layer from said second source substrate to said at least one organic light emitting diode.

15. The method according to Claim 14, wherein said step of selectively transferring said at least a second color changing layer includes the step of ablating said second source substrate to selectively transfer a portion of said at least a second color changing layer to said at least one organic light emitting diode.

16. The method according to Claim 14, wherein said second source substrate includes a release layer selectively positioned between said second source substrate and said at least a second color changing layer.

17. The method according to Claim 14, further comprising the steps of:

removing said second source substrate after transferring said at least a second color changing layer from said second source substrate to said at least one organic light emitting diode;

providing a third source substrate having at least a third color changing layer formed thereon;

positioning said third source substrate adjacent said wafer; and

selectively transferring a portion of said at least a third color changing layer from said third source substrate to said at least one organic light emitting diode.

18. The method according to Claim 17, wherein said step of selectively transferring said at least a third color changing layer includes the step of ablating said third source substrate to selectively transfer a portion of said at least a third color changing layer to said at least one organic light emitting diode.

19. The method according to Claim 17, wherein said third source substrate includes a release layer selectively positioned between said third source substrate and said at least a third color changing layer.

20. The method according to Claim 13, wherein said first source substrate further includes an adhesive layer positioned on said at least a first color changing layer.

21. The method according to Claim 16, wherein said first source substrate further includes an adhesive layer positioned on said at least a first color changing layer.

22. The method according to Claim 19, wherein said first source substrate further includes an adhesive layer positioned on said at least a first color changing layer.

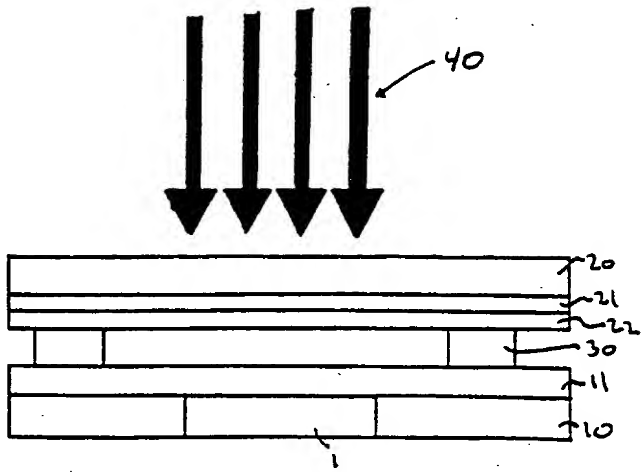

FIG. 1

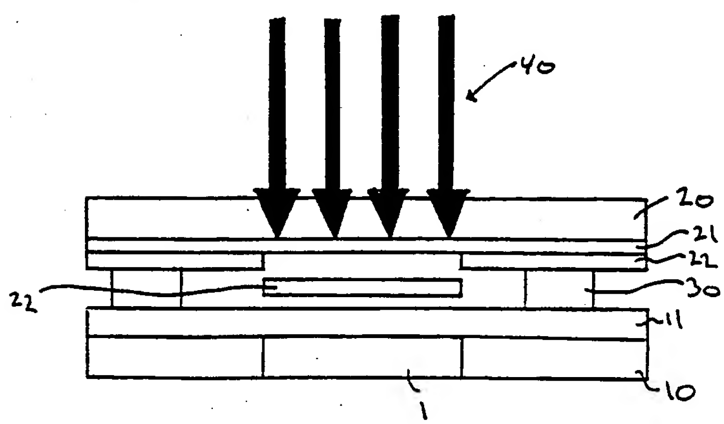

FIG. 2

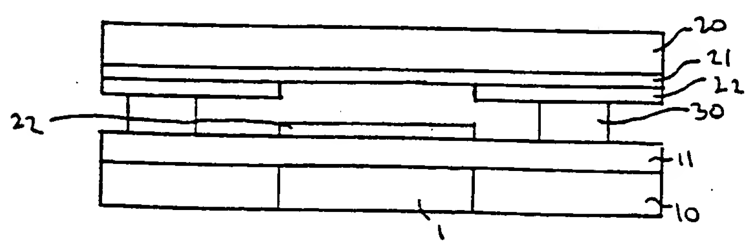

FIG. 3

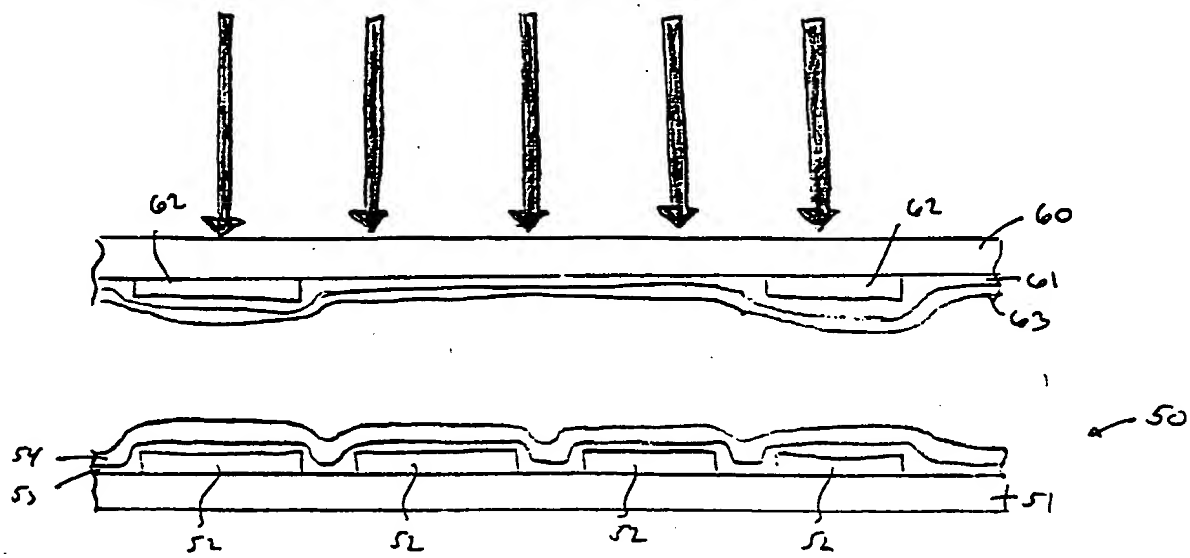
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FIG. 4

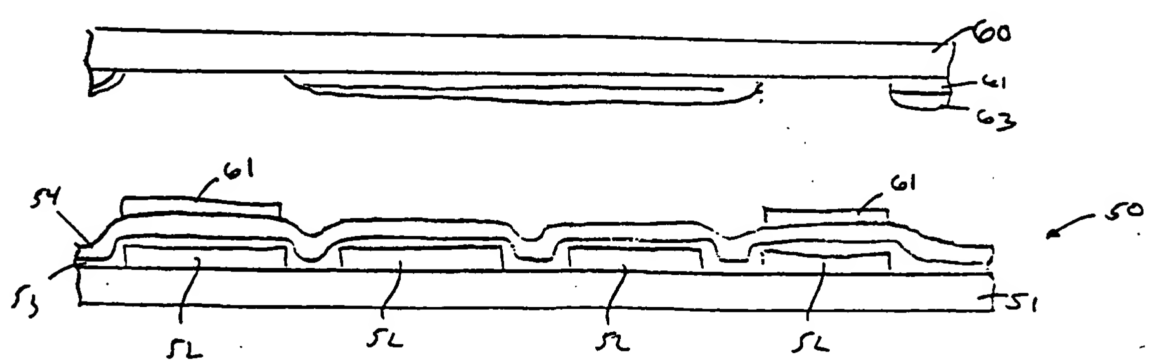
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FIG. 5

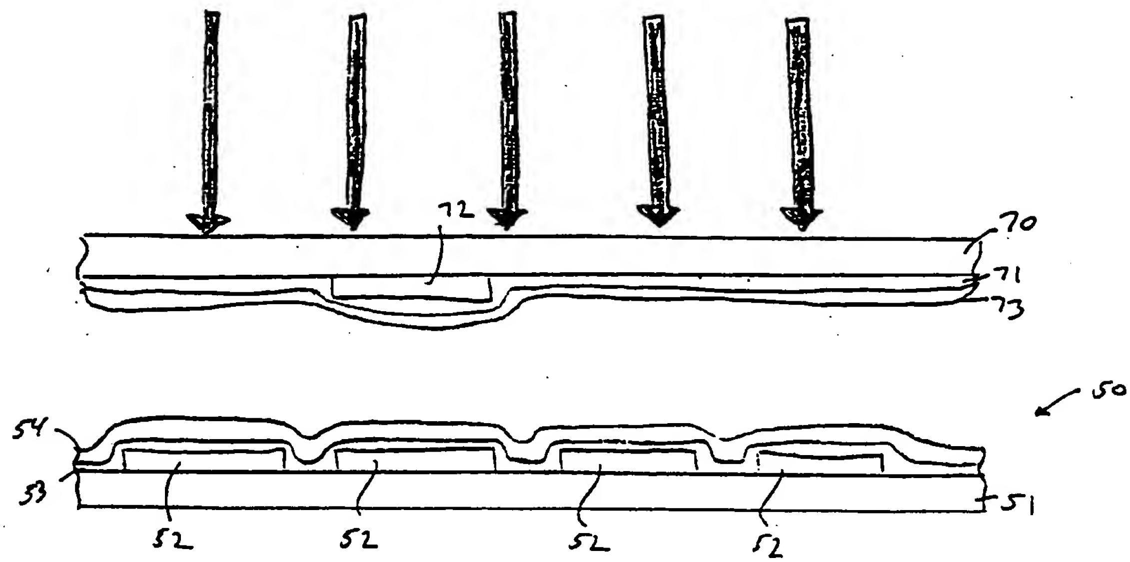
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FIG. 6

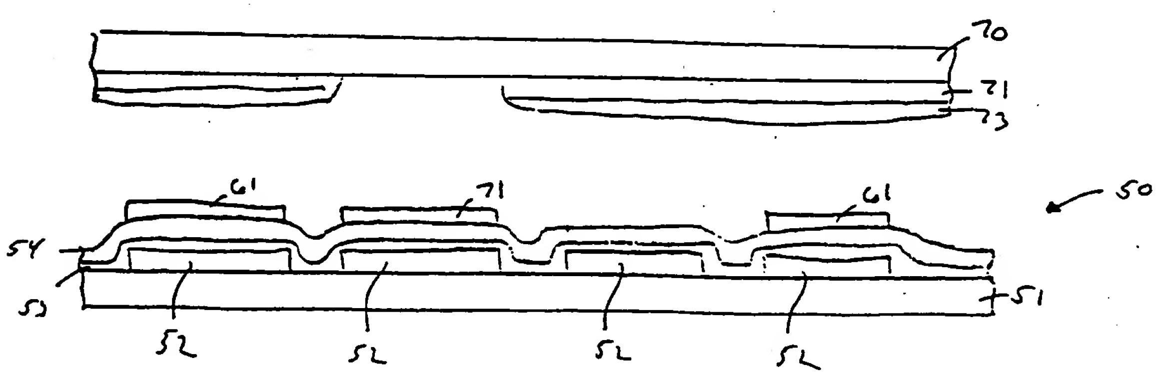
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FIG. 7

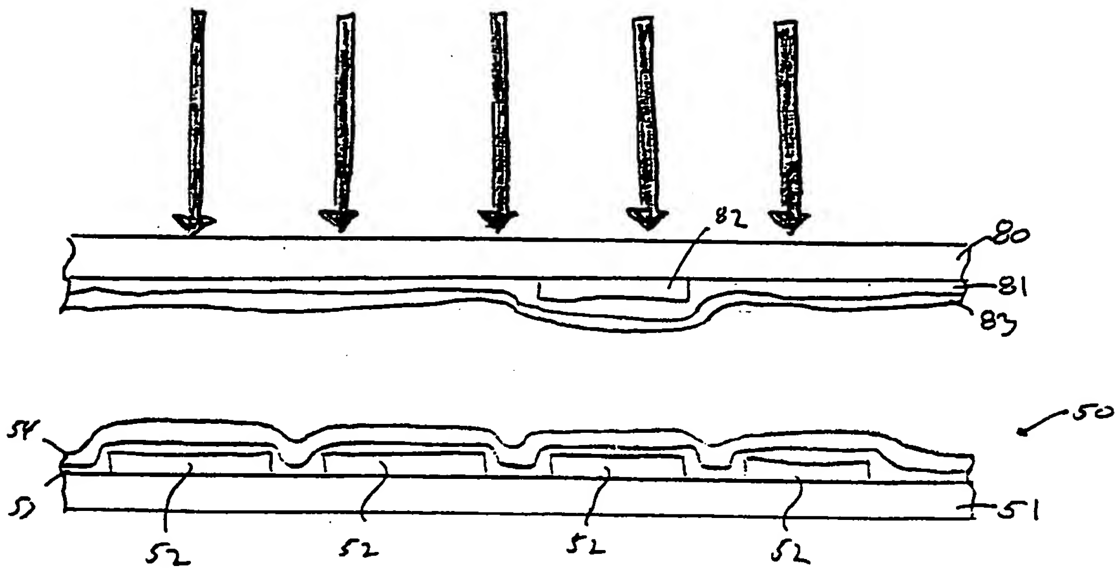
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FIG. 8

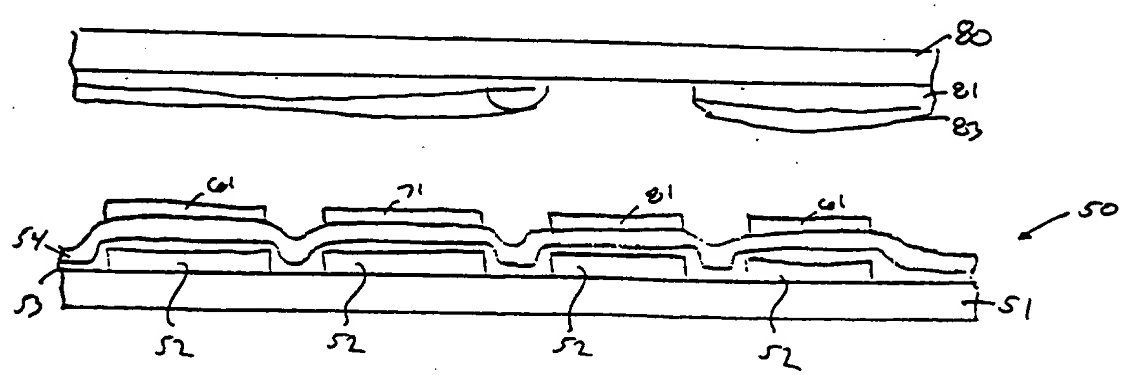
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FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/20107

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H01L 21/00, 51/40
US CL :438/ 29, 34, 35, 48, 57, 66-70, 72, 73, 82, 99
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 438/22, 29, 34, 35, 48, 57, 66-70, 72, 73, 82, 99

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST/USPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,583,350 A (Norman et al.) 10 December 1996 (10/12/96), the entire reference.	1-22
A	US 5,686,383 A (Long et al.) 11 November 1997 (11/11/97), the entire reference.	1-22
A,P	US 5,736,754 A (Shi et al.) 07 April 1998 (07/4/98), the entire reference.	1-22
A,P	US 5,773,130 A (So et al.) 30 June 1998 (30/6/98), the entire reference.	1-22
A,P	US 5,858,561 A (Epstein et al.) 12 January 1999 (12/01/99), the entire reference.	1-22

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search
13 DECEMBER 1999

Date of mailing of the international search report
07 FEB 2000

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3230

Authorized officer
KHANH DUONG
Telephone No. (703) 308-5840